# Digital diagnostics from Tanzania: Beyond mere technological fixing?

Tom Neumark

*Institute of Health and Society and the Centre for Development and the Environment, University of Oslo, Norway*

### A B S T R A C T

Digital and data-driven technologies are increasingly being deployed in healthcare systems around the world, and used by individuals seeking to improve their health. Major global health institutions, from the WHO to the Gates Foundation, are arguing for their importance in the building of healthcare futures across the world. For critics, however, the broad enthusiasm for digital health has raised the question of whether too much faith is being put in minimal, 'technological fixes' driven by the market for problems that have intractable social determinants. This article focusses on a group of apparent technological fixers, Tanzanian data and computer scientists designing and building various forms of digital diagnostics. It argues that these diagnostics, and the social forms they are creating, need to be understood differently than as purely attenuated, market-driven technological solutions for specific problems. Instead, they represent ambitious efforts to create new and superior healthcare futures from Tanzania, that speak to broader systems as much as abstract and narrow technical processes, and to the public good as much as the private.

## 1. Introduction: The digital turn in health

Medical technologies have proliferated since the dawn of modern medicine in the 19th century, and, from the late 20th century, these technologies have taken an increasingly digital and data-driven turn. In the process they have created an industry that was in 2019 worth $350 billion globally, and which has thrived under the COVID-19 pandemic (Cohen et al., 2020). They have also generated widespread academic attention, most recently in the Lancet/FT Commission on *Governing Health Futures 2030: Growing Up in a Digital World* (Kickbusch et al., 2021), which argues that digital technologies are already having considerable effects on health and well-being and are set to play an even more profound role, even potentially helping to achieve universal health coverage. Today the digitalisation, which includes the datafication, of health has become such a wide phenomenon that to describe it as such risks losing specificity. Under its umbrella it may include such diverse phenomena as worried teenagers Googling their symptoms, data scientists modelling data for vaccine development, health information platforms deployed in a healthcare system, and much more.

While lower income countries such as Tanzania were once largely on the margins of processes of digitalisation, with computing devices and infrastructures confined to urban centres (Mercer, 2006), the proliferation of mobile phones and digital devices, as well as the expanding reach of 4G telecommunications – while still uneven – represents a sea change. Since 2012, the Tanzanian Government has considered digitalisation to be key to the improvement of its health sector through its purported ability to improve, among other things, the flow of, and access to, health information, the management of human and material resources, as well as decision-making processes at multiple levels (Government of Tanzania, 2012, 2017).

In this article, I focus specifically on how digitalisation is shaping technological innovation around diagnostics in Tanzania. While I contribute to a growing body of social scientific knowledge concerning diagnostics (Beisel et al., 2016; Arora, 2010; Street and Kelly, 2021), I am also interested more broadly in the development of emerging digital health and medical technologies, outside, but always in connection with, traditional innovation locales, such as Silicon Valley. Studies exploring this phenomena have, however, tended to focus on the 'downstream' of these technologies – that is, their emergence in, and impact on health care facilities and laboratories. In contrast, this article dwells purposely 'upstream' on the design and building of diagnostics by a set of Tanzanian data and computer scientists, whom I refer to as technologists. By focussing on these actors, I aim to widen and strengthen social scientific, including anthropological, knowledge of the digitalisation and datafication of health (Jensen, 2010; Lupton, 2018; Hampshire et al. 2015, 2021; Lang, 2021; Rao, 2022).

Diagnostics have become an especially popular way through which to deploy digital and data-centric tools but, to date, they have not been explored extensively or ethnographically, particularly in lower-income countries in the global South. Observations from my own fieldwork, in Tanzania, suggest that new vibrant spaces are being created for novel forms of digital diagnostics. I have encountered rural villagers and urban dwellers alike turning to mobile devices, particularly smartphones, to access information for self-diagnosis as well as to connect with

healthcare providers, often informally, to seek diagnoses and more. As this takes place, dedicated digital health companies have also already made incursions into Tanzania and its neighbouring countries. The UK-based Babylon Health, with private investment of above $1 billion, have integrated telemedicine services into Rwanda's public healthcare system, while the German-based Ada Health, with support from the Gates Foundation, are adapting their text-based medical diagnostic app to the Tanzanian context. At the same time, as explored in this article, these well-financed foreign companies are also joined in Tanzania, by local companies, entrepreneurs and researchers in universities, private offices and in innovation 'hubs' that are appearing with increasing frequency in urban centres across the country. These actors do not stand alone but commonly partner with their counterparts abroad, in neighbouring countries and further afield, as well as depend upon the digital infrastructures of the likes of Google and Facebook for internet access, data storage and computational capacity.

Technologies in the fields of what have become known as global health, humanitarianism and development have recently been understood as intertwined with a dominant ideology of, distinctly capitalist, technological fixing. This ideology has been held and propagated most forcefully in global health by the Gates Foundation, which has been said to focus on market-driven, pragmatic, and often minimalist, technical solutions to specific problems (Birn, 2005; Storeng, 2014; Fejerskov, 2017), oftentimes which serve as technical adjustments to the status quo of life off the grid or away from traditional healthcare infrastructures.

What I present in this article does not aim to dispute the influence of the Gates Foundation on global health policy, nor its own ideological viewpoint. Vigilant, critical approaches have explored, and will continue to scrutinise, the changing dynamics of health policy making and the technologization of health. However, it is my contention that these approaches, when applied to health technologies, often appear to downplay the sociality and systematicity of what science and technology scholars have called socio-technical systems. It is not *only* that ostensibly capitalist technical fixing is itself a resolutely social phenomenon, as well as, of course, a political, economic, cultural and ethical one, involving, as it does, the interplay between institutions, beliefs, values, money and material. But it may also involve actors that think and seek to act systematically. Indeed, the market, said often to be a driving force behind these fixes, is itself a complex system. Yet, as I will also explore, technological development might not always be solely concerned with bolstering a market system, even if it must increasingly work within it.

Focussing on the Tanzanian designers and builders of digital diagnostic technologies, I am interested in the ways in which technological development on the margins of a global scientific and technological health and medical economy engages with and builds a variety of systems of a social and technical nature. This approaches means moving away from the designation of digital health as best understood as 'asocial', minimal, market devices, with predetermined outcomes, which, often lead to technology being cast, as Donna Haraway has put it, as 'the enemy' (Haraway, 2016, 3). Following Haraway, and others (Harvey and Knox, 2015), I hope to demonstate how close, ethnographic attention to the building of digital health by Tanzanaians may force us to ask new questions about the appeal, the diverse manifestations and the contingency of digitalisation and datafication (Pink, 2021).

## 2. Methods

The article is based upon nine months of fieldwork conducted in Tanzania between June 2019 and March 2020, as well as a smaller amount of online fieldwork between 2019 and 2022, using WhatsApp, Telegram, Twitter and Zoom. A major element of this fieldwork has involved tracking particular digital health projects and companies. Many of the technologies were in an early stage of development but one had begun to be piloted in some healthcare facilities, and where possible, I joined these pilot studies. The fieldwork primarily involved

participant-observation and unstructured interviewing across a range of sites including laboratories, tech hubs, offices, cafes, in cars and healthcare facilities. In practice, this meant the sites of the data collection were situated across Tanzania, in urban locales, including Dar es Salaam, and peri-urban and rural health facilities.

I received ethical clearance for this research in Norway from REK, and in Tanzania from the National Institute for Medical Research. I received research permission from the Commission for Science and Technology. All participants have been anonymised, except where they themselves have chosen to publicly connect my research with their own activities.

## 3. Health for all, digital health and diagnostics

In its latest digital health strategy, the government of Tanzania has stated that digital technologies will help to 'fast-track progress toward attainment of universal health coverage' (Governnment of Tanzania, 2019). But unlike in other countries, such as neighbouring Kenya where universal health coverage as a distinct policy has been officially piloted (see Muinde and Prince this issue), the explicit policy term, or its acronym UHC, has not become a household name in Tanzania. This is not to say, however, that ideas of universality of healthcare have been absent from the public sphere. Most relevant have been discussions concerning the not-yet-passed Universal Health Insurance Bill (*Muswada wa Sheria ya Bima ya Afya kwa Wote)*. This bill emphasises access to health insurance for all Tanzanians, echoing the typical emphasis that has been placed by many governments experimenting with UHC of improving financial protection and access to healthcare services. In a digital tech space that has been characterised over the last decade or so by fintech, in Tanzania but also in other African countries, the focus on financial protection and access in the UHC agenda has also provided opportunities to develop new forms of health insurance, such as MTiba mobile money wallets (Neumark and Prince, 2021). Doing so, however, sometimes neglects attention to the *quality* of healthcare services that is accessed (Rubinstein et al., 2018).

It was to the quality of healthcare infrastructures that the technologists in Tanzania I knew concentrated their efforts. They regularly spoke to me of the importance of ensuring that Tanzanians, even in the most rural areas, are able to access the same sort of healthcare that others in the country enjoyed. Important to many of them was the development of cheaper and more accessible diagnostic devices. Some of my interlocutors saw ways in which digital and data-driven diagnostic devices could be designed to operate outside of laboratories, taking advantage of what is often referred to as ubiquitous computing, and allowing diagnoses of conditions such as cancer to take place in, for instance, mobile medical camps or in people's homes. Others, such as those designing the malarial diagnostic devices that I discuss below, saw the possibility of new diagnostic devices helping to build laboratory capacity in more rural healthcare centres. Still others imagined how digital and data-driven technologies might be integrated into the clinical encounter to benefit healthcare workers. Recognising that healthcare centres in certain, often rural, areas relied upon healthcare workers with lower levels of training, they experimented with how algorithmic-orientated technologies might form virtual assistants, aiding in decision-making in the diagnostic and treatment process.

In all these use-cases, technologists remain committed to the idea that healthcare, and specifically diagnostics, for more marginalised populations should be of better quality. But at the same time, they also imagined a future public healthcare infrastructure that relied upon digital technologies not only to improve quality, but also to make it more accessible. Moreover, they often explicitly connected the existing diagnostic situation in Tanzania with the financial hardship of their fellow citizens. For instance, late diagnosis inevitably meant the progression of a disease, such as cancer, necessitating lengthier hospital stays, often in cities and away from family, that came with significant costs. So, while few technologists I knew invoked the concept of health for all, its

principles were infused into their motivations, reflections and choices.

## 4. Fixing things with technologies – an age-old tension

The role of technological innovation in the field of global health has been contentious, particularly with the rising power of the Gates Foundation (McGoey, 2016). In the early 2000s, in an opinion piece in The Lancet which has been cited hundreds of times, leading global health scholar Anne-Emanuelle Birn criticised the philanthropic organisation for its 'narrowly conceived understanding of health as the product of technical interventions divorced from economic, social, and political contexts.' (BirnAnne-Emanuelle, 2005, 515). While Birn was speaking specifically to the ideology of the Gates Foundation, her concerns spoke to a belief that has been articulated since at least the 1960s. As the historian Rosner (2004) has recounted, the nuclear scientist Alvin Weinberg was, in that period, possibly the first to advocate for 'cheap technological fixes'. Even at the time, he received a response that today looks strikingly similar to Birn and her contemporaries' arguments, and which exemplifies the critical connotations of the idea of technological fixing in the present day (Morozov, 2012). John G. Burke, for instance, wrote in 1969 that 'Technological means may be available to solve the population problem, for example, but it has become quite obvious in recent years that sociological and psychological methods will be crucial in effecting a real solution' (quoted in Hughes, 2004, 2). James Ferguson (1990) took this argument further in his study of the World Bank's operations in Lesotho. The issue was not just that the bank ignored social realities in favour of technical solutions, but that they continued to play a political role with profound political implications.

The calls, made for over half a century now, to look beyond technology and a technological innovation for solutions to problems, seem to have remained unheeded. For some scholars, the issue is of a powerful ideology that is rooted in and emanates from the US. For historian of technology Thomas Hughes, it is a religious ideology. 'A god named technology has possessed Americans', he wrote, and leads to a 'passion for the miracle of technological fixes' (Hughes, 2004, 208). Most recently, the rise of digital and networked-technologies, as well as a particular variant of the ideology of the technological fix focussing on innovation, which is often traced to the techno-libertarianism of Silicon Valley (and further back to the counterculture of Stewart Brand and the Whole Earth Catalog) has exercised critical scholars (Morozov 2014; Scott-Smith, 2016).

Hughes suggested that the technological-fix must be challenged by 'a systems approach that deploys technology along with other components that respond to the complexity of the problem to be solved.' (Hughes, 2004, 208–10). It is the same argument made by Birn who advocates for a shift in the ideology towards social engineering, or a reform of the 'socio-' in what STS scholars have called socio-technical systems. For instance, in attempting to improve nutrition, the Gates Foundation, Birn proposes, could combine a pilot project in a particular locale, involving various different experts and community participation, with 'international currency bailouts, farming subsidies in industrialised countries, and social security systems' (BirnAnne-Emanuelle, 2005, 517). While the Gates Foundation already shapes national policies, as scholars have long argued, and indeed their technological orientation is itself an inherently social (in the widest sense of the term) process, this proposed shift in approach would see it expanding its interventions to new sectors and issues that are seen as determining healthcare systems and health outcomes.

The critique of technological fixing is often levelled at large-scale, ambitious schemes, both in global health and beyond. Geo-engineering, such as carbon capture, and industrial-sized renewable energy projects are popularly understood as important exemplars. However, a particular subset of technological fixing is seen in the devices that are being designed for people living off grid in the global South, or what policy-makers often call the 'last mile', who live away from, or with marginal access to, the traditional, modernist

infrastructures of water, sanitation, electricity and healthcare. Often physically at a small-scale, such as off grid solar modules or water purifiers, these technologies are also seen to represent scaled down *ambitions* for change (Collier et al., 2018; Neumark, 2022). These might be understood, as Redfield (2022) argues, as market-based solutions for the 'meantime', ones that keep people supplied with the basics of survival until the state, the political authority that is imagined to be legitimately responsible, takes responsibility. This phenomena perhaps reaches its zenith in contemporary forms of humanitarian interventions, although it is worth remembering that the logic and practices of humanitarianism now characterise more than just the traditional interventions, such as food aid, and stereotypical sites such as refugee camps, and now extend to legal regimes in the global North (Ticktin, 2011) as well as to other sites in the global South, including cities (Lucchi, 2012).

The picture that has been painted, and one that I have necessarily simplified here, appears to be of a global health world that has neglected systematic approaches, whether in regard to wider societal relationships, healthcare systems or more materially in the sense of infrastructure, towards a greater emphasis placed upon more narrow technological, and often market-orientated solutions to specific problems that offer people the basics. In what follows, I wish to explore how an ethnography of technical actors and their technologies in Tanzania may begin to complicate this picture, and allows us – indeed, forces us – to ask other sorts of questions.

## 5. Ambitious design: a case study of a new way of diagnosing malaria

Contemporary humanitarian, global health and development related technological innovations, as well as their 'appropriate technology' predecessors of the late 20th century, appear to different sets of people as different things. A given technology may be perceived variously as an ingenious solution to a problem, an inferior substitute for the 'real' thing, or even as a fundamental failure of political will. By way of an example, we can consider the malaria Rapid Diagnostic Test (RDT). RDTs for malaria have become common in Tanzania's public healthcare system because of their apparent simplicity, mobility and their capacity to provide diagnoses without the supportive infrastructure of electricity and laboratories. While in practice things are, as they always are, more complicated (Beisel et al., 2016), the RDT could be understood as a clever way of providing malaria diagnoses in places lacking the supportive infrastructures of well-stocked laboratories or an inferior way of diagnosing malaria or even be symbolic (and a symptom) of a lack of will to attend to the wider unevenness of public diagnostic infrastructures. Additionally, the RDT might appear to some to be yet another example of the dependence Tanzania's citizens have on outsider medical expertise and industry.

Other health technologies seem harder to categorise in this way. Take the example of a new type of device for diagnosing malaria developed by a group of Tanzanian data scientists (both students and staff) from the University of Dodoma whom I met and spent time with in 2019. The university does not offer a data science degree, although there are attempts to establish one. The group I spent time with were therefore self-trained in techniques of machine learning, and were able to draw from their expertise gained through their undergraduate degrees in computer science. At the university, or even elsewhere in the country, there was also insufficient computational capacity available to the group to deploy their chosen machine learning techniques, forcing them them to run their models in the cloud. They were, for instance, able to use 'vouchers' for Google Colab that one of them had received after attending a prestigious conference in Canada the year before.

The problem the group were trying to solve pertained to the key drawback of the malaria RDT: it only offers a qualitative diagnosis; that is, it only has the capacity to identify whether or not a blood sample is infected with malaria. Moreover, the RDT does not work very well with the early stages of malaria. Instead, the group wanted to find a way of

offering a *quantitative* diagnosis, a type that would show the severity of the disease, as well as catching it earlier. The WHO gold-standard for achieving this in malaria is a microscopy test (WHO, 2015). But there are problems with this in Tanzania. Well-trained laboratory technicians are in short supply in the public healthcare system and not equitably distributed across the country. Those who are employed must spend a long time at the microscope manually observing and counting the number of *plasmodium falciparum* parasites on a blood smear slide. This work is fatiguing and therefore also subject to human error.

The group in Dodoma envisaged the possibility of solving some of these problems by utilising the recent advancements made in computer vision machine learning, some of which was now increasingly accessible to them through their personal computers and the cloud. The idea they settled upon was to design a 'smart' microscope. The hardware would incorporate a smartphone attached to a standard laboratory microscope, with the phone's camera directed through the microscope's ocular lens. In this new device, the operator would be longer required to look through the lens with their own eyes, but would instead take a series of photos with the smartphone. These photos would then be processed by an application on the phone that would automatically recognise, and count, the parasites, thereby offering the operator an accurate, WHO-certified gold-standard diagnosis.

When I met them in 2019, the group had developed their first prototype. It was using publicly available datasets, from Makarere University in Uganda, that they had run through a convolutional neural network. But the results were not as promising as they hoped. They were now setting out to collect and use their own primary data, which they also made, they stressed, publicly available, so as to serve others who might want to develop similar solutions. In fact, their aim was not only to improve the accuracy of their application but also to improve the collection of data, by developing another application that would help them to automate the process of annotation. This, they argued, would also make data collection and annotation much easier for other researchers in Tanzania and beyond.

At the time of my fieldwork, this was a research project, and it has to date not been deployed in any healthcare facility or laboratory. But this is exactly the sort of project that is taking place across Tanzania's universities and research institutions, sometimes involving partnerships with foreign universities and often funded by development aid. Many similar groups are turning to the possibility of diagnosis (and treatment advice), and are at different points in the product pipeline. At another health research institute in the country, a different group of researchers were developing a smart microscope for malaria, similar to the one from the University of Dodoma. Both examples are attempts to move beyond the minimal technological fix as a way of producing a more superior, but still technological, solution to malaria diagnosis. In this way, they seek to enact what some scholars have been arguing for; that is, a way for countries in the global South to avoid unnecessary and costly existing pathways of development and infrastructure, and instead forge their own (see also Gupta, 2015). Seen in this light, and as Redfield (2022) has argued, such efforts point to the more ambitious, even progressive, sensibilities of those technologies often cast as poor substitutes for the 'real thing'.

## 6. Systematic thinking beyond the technological fix?

If certain technologies begin to open up questions about superior technological ways of solving problems, at the same time they begin to move us to the familiar hubristic world of digital tech. In place of incremental, seemingly unambitious or modest solutions, we are presented with maximal, even revolutionary, claims for digital technologies even if the claims are for solutions that remain resolutely technical in nature rather than more broadly sociopolitical (Koselleck, 2004, 44). Such claims appear often as *overly* ambitious, coalescing into what often appear to bystanders as a collective exaggeration of possible technological futures (Rajan 2006; Chan, 2019). There was no shortage of this

during my fieldwork in Tanzania. During that time, most of the Tanzanian technologists I knew attended a tech conference that was, that year, titled *Africa in the Fourth Industrial Revolution* – a term coined by Klaus Schwab (2015) of the World Economic Forum. The keynote speech, delivered by an American professor employed at the infamous Silicon Valley institution Singularity University (which is, in fact, a company rather than accredited university), sought to persuade the audience of the 'law' of exponential growth that characterised current, largely digital, technologies – a theory put forward by futurist Ray Kurzweil (2001). The effects of this 'law' however, the keynote speaker argued, could end up being unevenly distributed across the world. The speaker urged the audience of Tanzanians to adopt an 'exponential mindset' as a way for them to wrest control over global technological process. The message portrayed was now very far away from that expressed by the minimalistic, small-scale solutions that have tended to characterise global health and the related field of humanitarianism, even if the speaker's proposed solution to epistemological and technological disparities (to change one's mindset) was itself far from speaking to anything that might look like a global system. In other words, the young Tanzanians in the audience were encouraged to join the inevitable march of (now exponential) progress, lest they be left behind. If the technologies were apparently exponential, the direction the world was taking in this picture seemed to be more straightforwardly linear and one-dimensional.

The argument positing an ideology of technological fixing in global health tends to presume the interpellation of people (and institutions) into dominant ideas about technology as a solution to all problems. To some extent, there is evidence for this in Tanzania. After the conference, I regularly heard the technologists I knew invoking the ideas of both the Fourth Industrial Revolution and exponential technologies. In 2020, the University of Dodoma group submitted a paper to the prestigious *International Conference on Learning Representations* that was, before the outbreak of COVID-19, to be held in Ethiopia, the first time it would be held in sub-Saharan Africa. The conference's abstract opened with these lines: 'The exponential growth in digital technologies characterizing the fourth industrial revolution, such as artificial intelligence, offers an exciting opportunity to save lives threatened by malaria across sub-Saharan Africa' (Shaka et al., 2020, 1).

One perspective would be to see the University of Dodoma group having occupied subject positions within ideologies of technological fixing, and the more ambitious digital version one too. The result would be that perspectives that stress the importance of determinants of health – or in other words, wider societal arrangements – are out of consideration. Indeed, I never heard my interlocutors talk about measures such as 'social security systems' or 'international currency bailouts' which, as I have mentioned, Birn posits as ways to move to more systematic approaches to global health.

But because such measures were rarely expressed by technologists did not mean that they were unaware of them. Instead, among my interlocutors, they were often bracketed outside their own work, considered as political issues that were properly beyond the remit of the technologist. Yet, at the same time, their bracketing of *particular* social systems at scales that reached beyond the healthcare system, here understood by them as political, did not mean that technologists were *per se* anti-systematic. The idea of improving malaria diagnostics was seen by my interlocutors not only as helping to address one specific disease, but also as a step on a path that would lead to strengthening the country's laboratory capacity, and therefore Tanzania's public healthcare sociotechnical system. Understanding systems to be occupying and enacting different scales, allows us to be open to their diversity.

Opening to the diversity of systems-thinking, also offers us a way to look at how new technologies offered those whom I knew opportunities to address 'systems' in other ways that took them beyond health. Many of the technologists that I knew did not necessarily even see themselves strictly as health specialists. In the same way that social scientists apply similar models and theories to diverse objects, the technologists I knew

regularly deployed their expertise to problems in different sectors. These included 'domains', or in other words, specialist knowledge outside of software or data engineering, and within a range of sectors including finance, agriculture, water, education, energy, and even language. But, as with health, this did not mean a shift to a more 'systems' approach that might emphasise other sorts of social policy reform that critics and activists argue are essential for better health outcomes. With their vocation in new forms of engineering, this would not come to the reader as a surprise. Yet, as anthropologists have argued, it would be a mistake to see engineering as abstracted and freed from the social relations of the world, when their entanglement and engagement with them is always a prerequisite for the successful completion of any technological project (Harvey and Knox, 2015). No less was this the case for the technologists in Tanzania who found that their technical work was often over-shadowed by what we might call their relational work. One, whom I knew well, often complained that he spent ninety percent of his time speaking with government bureaucrats and ten percent of his time actually involved in the coding and analytical work. This was not about convincing reluctant government bureaucrats of the necessity of a technical quick-fix but rather about working with them to explore how new technologies might be best incorporated into wider, existing public healthcare systems.

As well as working with existing 'domain' systems, my interlocutors also thought about social relationships more widely, particularly about Tanzania's, and often Africa's, place as situated on the margins of global relationships of science and technology. New digital technologies offered a way for some young, largely middle-class, university educated people from the continent to challenge this situation by taking up their own position on the frontier of a movement that they, and those of their fellow citizens, saw the world as heading towards. As a a *bajaj* (a rick-shaw) driver told me in a conversation we were having about the Uber app he was now using, *tunasonga mbele* – we are moving forward. For Tanzanians, moving forward is connected with what they term *maendeleo*. The English translation of the term is 'development', but its etymological roots, from the verb *kuendelea,* means not only to progress or grow, but also to go forward or ahead. However, for some of the technologists, if Tanzanians are to be more than bystanders of this forward movement, and instead shape it, they also may need to find inspiration by reaching back in time. Perhaps most commonly to the reflections of the first president Julius Nyerere. Writing a blog post in English, one prominent Tanzanian technologist, Jumanne Mtambalike (2018), quotes Nyerere saying '*We have many people in the South who know a lot at the same level of knowledge as in the North. We have to develop the knowledge into tools that can help with the development of our regions'*. Mtambalike argued that Tanzanian public institutions must turn '*knowledge into useable knowledge'*. However, even though Mtambalike looked for inspiration in Tanzania's socialist past, and was a tireless supporter of building public sector institutions friendly to technological development, he also recognized the role of private capital, as he sought to help build an eco-system in the country that connected to foreign, African and Tanzanian private investors.

Efforts to shape Tanzania's collective socio-technical futures in a way that aligned with what was seen as global progress around digitalisation and emerging technologies were inevitable intertwined with personal projects within such futures. This was not only the case for those, such as Mtambalike, with public facing roles but also for the more technical actors. John, one of the members of the Dodoma group, said his parents had encouraged him to study software engineering. While others had suggested to John that a traditional subject like mechanical engineering would lead to government employment, his father advised him that software engineering 'is the way the world is going'. For many like John, these skills promise the offer of opportunities for employment in the future. As Maia Green has argued in relation to the development sector in Tanzania, becoming an *utalaam* (expert) in Tanzania is dependent upon gaining access to particular institutions and relationships, that also help people to *kujenga maisha* (to build a life) (Green, 2014).

Nevertheless, futures are ultimately contingent and uncertain, and those like John considered themselves as taking a significant risk, particularly when the government at the time seemed more interested in the skills of mechanical or structural engineering, than those relating to the digital realm.

While personal ambitions are a part of the picture, it would be reductionist to see Tanzanian technical actors as concerned simply with personal growth and security. Many are keenly interested in challenging Tanzania's long-standing structural position as a recipient of technologies. At a conference in Canada, an American scholar who saw John's poster presentation and the work he was undertaking, told John that he was doing 'serious stuff', even though he had still not completed his undergraduate degree. Another male employee at Google, heard about John's work in Tanzania and declared that he himself would 'love to do something like that' (John assumed he meant applied work) rather than the 'theoretical' work he was doing at the company. Tanzanian technologists, like John, also joined pan-African technology conferences and hackathons, sometimes connecting to black technology movements in the US (such as Black in AI). While some spoke about Tanzania explicitly, others also talked about the role that the wider continent of Africa might be playing, or might be able to play, in the development of new technologies. I also often heard them argue that the problems they were attempting to solve with new technological innovations were *important*, unlike those of their counterparts in countries like the US, who were interested in simply oiling the machinery of consumerism. For many of my interlocutors, their 'serious work' was a way not only to help fellow citizens encountering some of the most profound and essential problems of human life, but also to feed into processes of technological sovereignty, all the while that sovereignty was, of course, being undermined by the likes of Big Tech companies, including Google.

At certain strategic moments, my interlocutors also sought to make explictly political interventions. At the WHO/ITU conference mentioned earlier, one former Tanzanian government official, who had held a senior position related to science and technology, told the delegates, 'The solution will come from us. There are 600 tech hubs across Africa, and a number of entrepreneurs are developing algorithms. Research institutions here need to be involved to prevent this to be another digital divide'. While the digital divide is a label commonly used to describe the gap between those that can and those that cannot make use of new digital technologies, here, the official wanted to draw attention to a divide in the making of technology. A young data scientist, later addressed the audience, adding to these sentiments, 'We need to be careful as Africa is becoming a testing place, where things are evaluated and taken elsewhere', before adding, diplomatically, 'We won't mention names'.

While computer and data scientists in Tanzania may still be considered to be a part of a larger phenomena of technological fixing that tends to downplay the societal relations that shape health, from a certain perspective, once that requires widening the lens to see other sorts of social relationships, they still think and act *systematically*. In fact, in the current COVID-19 pandemic, as questions are being asked more frequently about the global relationships, legal regimes and norms that shape the availability of medical technologies across the world, it becomes important to pay closer attention to the ways in which technical actors in places like Tanzania are becoming a part of movements that are questioning the ways in which science and technological knowledge, expertise and materialities are distributed across social relationships at global scales.

## 7. Navigating the private and the public

Critiques of technological fixing in health in the contemporary era frequently speak to the integral role of the market (Redfield, 2016; Scott-Smith, 2016; Prince and Neumark, 2022; Neumark, 2022). The ambition to find technological solutions to problems is, in other words, often understand as a distinctly capitalist endeavour. In this final

section, I explore how Tanzanian technologists thought about the market in relationship to the public good.

The focus on developing digital diagnosis devices – in healthcare but also in agriculture, for example, to identify diseases in crops from image data – is popular in the Tanzanian tech space. One reason is that the technique of computer vision machine learning, which has advanced significantly in recent years, lends itself to diagnosis when combined with decreasing costs of hardware such as smartphones, microscopes and even ultrasound scanners. One of my interlocutors, a Tanzanian data scientist with a PhD in AI from a European university, told me that the idea for doing computer vision forms of disease diagnosis in Tanzania really formed in his mind in 2018 when TensorFlow Lite, an AI-related piece of software that could be loaded onto a phone, was released. The availability of new such technologies, plus an expanding digital infrastructure, has generated hopes for something more ambitious for the Tanzanian healthcare system's diagnostic capacity. Working within existing constraints of the current healthcare system, particularly the problem of an underpaid and understaffed workforce, but with the affordances offered by new technologies of lower costs, has led home-grown actors to attempt, as I have argued, to create new healthcare innovations that aim to match what better resourced healthcare systems, most obviously those in the global North, have.

But the development of new Tanzanian-designed diagnostics was hardly a result of technological advances alone. For many of the technologists it came from direct or indirect experiences of diagnostic capacity in the public health system. Applying a pragmatic view when reasoning that government healthcare expenditure was unlikely to increase significantly, these technologists considered better diagnostics a way of reducing the burden on an overstretched healthcare system, and therefore strengthening it. I regularly listened to technologists explain, in funding pitches or in interviews, that the digital transformation offered new opportunities for more equitable diagnostics. MD students at Tanzania's main public hospital in Dar es Salaam, for instance, had established their own free telemedicine service using their own voluntary labour, because, they told me, they had become disillusioned with treating patients at the hospital whose diseases had progressed beyond the point at which treatment was possible. If disease prevention was beyond the remit of these actors, its early identification, they reasoned, would go a long way to decreasing morbidity. While this, like the Dodoma malaria microscope, was a small-scale project and had yet to meet the exigencies of an investment landscape that often demands universalising, scalable products if it is to produce financial returns, the attempt nevertheless signalled ambitious rather than minimalist attempts to imagine and create new healthcare futures borne from the experiences of Tanzanians working for, with and around *public* healthcare systems.

This is, of course, not to say that working on healthcare technologies in the public sector was born from an uncomplicated desire to serve the public good. Indeed, dreams of significant foreign investment, and even to be bought out by foreign investors, circulated in the Tanzania tech space, including those working on issues of health. But to describe technologists only as *entrepreneurs,* as they often are, risks painting only a partial picture; one that obscures the diversity of values and principles that motivate those who have turned to the design and deployment of new technologies. Technologists in Tanzania frequently sought to work with the public sector, and other public employees, so as to learn about their problems and accordingly devise the necessary (technical) solutions. In this way, they tried to respond to the calls, which I heard expressed regularly by government officials in meetings and in private conversations, and in the blog cited earlier, to do research that would not be orientated simply to advancing knowledge, but also to produce the sort of knowledge that could be readily applied to the problems Tanzanians, and its state, faced. Moreover, not only were diagnostics being designed to address deficits that they saw in the public healthcare system, but it was that system that they often saw as the hoped for eventual home of their diagnostics. While donor aid and private

investment capital was, understandably in a country such as Tanzania, the usual and most reliable, albeit unpredictable, source of funding, it was the possibility of working closely with the government and its public healthcare system that was often of most interest to Tanzanians designing diagnostics. One start-up I followed was even willing to give up their own software code to the government, while others sought to put their data in public repositories and even open-sources their own code.

In a context of increasing foreign for-profit incursion into health in places like Tanzania, and questions about their role in what has come to be called data colonialism (Couldry and Mejias, 2019), the role of Tanzanian technologists and their relationships with the state raises questions about the political economies that might be emerging around healthcare. The Tanzanian technologists I knew could hardly be described as free-market zealots, but were rather pragmatic actors that wanted to somehow sustain their endeavours. When I asked a male data scientist, whom I knew well, and who at the time was looking for funding to enable him to collect data to build a cancer diagnosis device, whether he was interested in his device being integrated into a public or private healthcare facility, he shrugged, saying 'whoever is interested'. He had no strong commitment to either the private or public healthcare sector. He did, however, worry about the government's desire to bring Tanzanian developed technologies in-house, and had heard enough stories of their subsequent failure because, he argued, the government lacked the necessary expertise. When entering into contracts with the government, the technologists had to negotiate what they were and were not willing to give up – whether it was code, the data, or whatever they defined as their intellectual property. As we know from the growing literature on public-private partnerships in global health and beyond (Buse and Harmer, 2004; Bull and McNeill, 2007), we need to be wary of how private interests shape health agendas and outcomes. Yet for my interlocutors, the concern was how state interests might shape 'home--grown' technological and healthcare development. After all, it is worth remembering that despite the criticisms of market-led technological fixes, state schemes, as Scott (1999) argued some time ago in relaton to Tanzania's post-independence socialist experiments, are as much liable to failure and unintended effects as the avowed market-led, narrower technical solutions.

The perception by some of my interlocutors of a state that was often unfriendly to their activities led them to wonder if it made better sense for them to develop their technologies in more supportive environments across the border, such as in Rwanda or Malawi. That is not to say though that they naively saw the Tanzanian state as benevolent but ineffectual. They were well aware of the ways in which the state was attempting to take advantage of digital and data-centric technologies to increase political control, such as through new forms of surveillance. They, like other Tanzanians, had heard the late John Magufuli, who was in power at the time of my fieldwork, publicly admitting in a speech that the reason for a cabinet reshuffle was as a result of his monitoring of private phone communication between his ministers, who he warned, saying, '*Ninawatazama*' – I am watching them. Such well publicized events, as well as the personal experiences of my interlocutors and those they shared stories with, concerning data surveillance caused some wariness among Tanzanian technologists that their technologies, whether in diagnostics or in other non-health domains, may be appropriated or captured by the state. Yet, by and large, their concerns, unlike perhaps those of the critical scholar, focused less on how data may be appropriated, but on the very possibility of collecting essential data, considering the immense cost of data collection from a healthcare system with fragmented health information systems.

## 8. Conclusion

Universal health coverage seeks to ensure everyone has access to quality healthcare services without financial hardship. In many countries, including in Tanzania but also elsewhere (see Dahdah in special

issue), the issue of access and financial hardship has become the focus for governments, social enterprises and NGOs. This has often meant that existing and dominant economic discourses and political economies, centred around the market, have increasingly moved into healthcare in a broader process of financialisation of health. As Sandra Bärnreuther has shown in this special issue, this has sometimes meant a focus on entrepreneurialism as a supposed panacea for addressing deficiencies of investment in health. As these contributions also show, the proliferation of digital technologies, and new forms of fintech, has accordingly built upon long-standing ideas of producing self-reliant economic subjects, often through debt or other economic 'incentives' (see also Elyachar, 2005; Donovan and Park, 2019).

Medical technologies have often struggled to produce equitable health outcomes, particularly when a specific technology is at its infancy and associated costs are high (Timmermans and Kaufman, 2020). Yet, inequity also arises out of technologies that are ill-conceived and not appropriate to particular populations or cultures (Erikson, 2018). Moreover, in capitalistic political economies, medical and health related technologies are increasingly as much centred on profit generation, speculation and ambition as they are on equitable distributions of healing and well-being (Rajan 2006).

It is imperative that we continue to critically examine the design, coordination, financing, regulation, maintenance and use of medical technologies. These include the digital ones I have explored in this article, particularly as they increasingly attract interest as well as opportunities for financial speculation. However, socio-technical assemblages unfold in diverse ways as they work towards creating futures that are always, by nature, contingent (Pink, 2021). Understanding the open-endedness of the future in this way, does not however mean blind to political and economic relationships and interests. However, it does mean that we need a better understanding, which this paper has argued we may help to build through ethnographic methods, of the diversity of technology cultures, which are always hybrid and never pure. In this article, I have sought to explore some of the dimensions of an emerging culture of 'home-grown' health technology innovation in Tanzania, specifically their ambitions embodied in their technologies for public healthcare, their work connecting to wider global social relationships around science and technology, and their positioning in relation to the public good. Taking seriously the 'systematic' and not only 'technical' efforts of the designers of digital health technologies is, I suggest, a necessary step in better understanding technical actors as more than just technological fixers, and as actors who have other desires beyond cost-effectiveness, efficiency, or the transfer of the responsibility of health to individuals (for instance Lupton, 2018).

## Credit author statement

Tom Neumark: Conceptualization, Methodology, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Writing - Review & Editing.

## Data availability

The data that has been used is confidential.

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